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FILTERS

The invention relates to a filter, particularly to granular media filters for removing impurities from water in for example water treatment works.

Granular media filters as generally used in water treatment comprise a bed such as sand, anthracite, or the like particulate material, either alone or in combination, contained within a tank or pressure vessel and supported on a porous floor system connected to an outlet.

Water to be filtered is usually fed in at the top, flows through the porous granular bed and out through the floor, or underdrain, systems. The latter must be able to support the dead weight of the medium as well as the pressure loss resulting from the flow and also it must be porous to permit the water to pass while retaining the granular medium in position without passing to the outlet.

In addition, in most types of filter accumulated dirt is removed by passing water in the reverse direction at a higher rate than the forward flow. The distribution of this backwash water is in fact a more critical design feature than the forward flow.

There must be a minimum pressure loss at the point of discharge into the bed to achieve the desired evenness of flow across the bed. There are two factors that have to be considered, firstly the uniformity of flow into an empty filter through the ducts or pipes of the floor or underdrain, and secondly the control of the flow into the bed itself which has an unstable characteristic and can break down from even fluidisation into a situation known as spouting or boiling.

Indeed the rapid sand filtration process for the purification of water was invented early this century and is still used in a broadly similar form. Water treated with chemicals to collect contaminants into tiny particles is passed down through a bed of sand and the contaminants are retained by the sand allowing clean water to be collected in an underdrain system beneath the sand.

A variety of methods have been used to avoid particles of sand being carried down into the underdrain system, ranging from layers of gravel of decreasing size above the holes into the underdrains to the underdrains fitted with nozzles. A further general type of underdrain system comprises a plenum floor of porous material which allows water to flow through the pores.

It is common practice in washing filters to use gas, usually air to assist washing either before water or simultaneously with it. The same underdrain system should therefore be capable of distributing this air uniformly in the same way as with water.

Granular media filters, such as sand filters are generally cleaned of accumulated contaminant particles on a batch basis, using a backwashing process. The backwashing process is primarily a reverse flow of water up through the sand which carries the accumulated contaminants away to waste. In many filters, this process is improved by a flow of air up through the bed of sand which further agitates the sand grains and facilitates the removal of the contaminants.

In some designs of filter, the air and the backwash water are introduced concurrently through individual nozzles for distributing the upwards

flows of water and air respectively. In the majority of existing filters, the air flow precedes the water flow, with the air bubbles serving to loosen adhering contaminants for the water flow to carry away. The air assists the cleaning process by providing agitation.

Some modern systems utilise air and water distributed concurrently into the base of the sand bed, providing a combined air and water backwash. This is more effective than the separate air and water flows but requires special provisions to maintain the uniform distribution of air and water per unit area of filter floor. In some systems the air and water are combined in special nozzles below the sand. In other systems, the air and water are distributed separately and allowed to mingle close to the bottom of the sand bed so that virtually all of the sand bed is subject to a mixture of rising air and water.

Where a separate air distribution system is used, then a key factor is that the minimum aperture size through which the air or water, whether separate or combined, is introduced must be a small proportion of the minimum selected sand grain size to prevent ingress of the sand.

The second requirement for the means of introducing air is that the amount of air introduced to the bottom of the filter must be almost constant per unit area of filter floor, so that a similar amount of air rises up through each portion of the sand in the filter. Were this not the case, then it would be necessary to introduce excessive air into some parts of the filter to ensure an adequate flow to those parts receiving the least. If sufficient air is not supplied, then the sand would become clogged in those parts receiving inadequate air and the clogging would tend to propagate further into the sand bed, leading to failure of the

process.

In many designs the air and water are fed through the same ducts or pipes but the rates are then limited otherwise maldistribution occurs. A common alternative is the use of suspended floors with a plenum chamber below. The depth of the latter guarantees low velocities and stable uniform distribution but with the penalty of additional tank depth and often additional excavation.

To provide the necessary headlosses for distribution and to retain the medium nozzle strainer devices are extensively used. These add to the cost of the underdrain and also can be damaged, in some cases allowing the medium into the plenum or lateral pipes below.

Another prior system involves perforated lateral pipes which are buried in graded gravel of decreasing size from bottom to top. Hitherto it has not been possible to place the working media around the lateral without using gravel, in an economical manner, because of cost limitations and the difficulty of forming fine orifices in long lengths of pipe.

It is possible to operate with air and water distributed in sequence from the same lateral pipe, but difficult with air and water simultaneously over the lengths required for large filters as used in public water supply.

It is accordingly an object of the invention to seek to mitigate these disadvantages.

According to a first aspect of the invention there is provided a device for admitting a backwash fluid to filter medium of a filter bed,

comprising a member having a plurality of elongate through orifices adapted to allow passage therethrough of the fluid but not the media.

Thus, using the invention it is possible to provide elongate orifices, or slits or slots, hereinafter "a slot" or "slots" having a width less than the finest fraction of the filter medium.

The slots may each have a width of less than 0.5mm, suitably between 0.10 - 0.3mm and preferably about 0.25mm. This is operative in use to ensure that the finest fraction of media does not penetrate the member.

The member may comprise a tube and the slots may be directed longitudinally of the tube. This is a relatively simple yet effective construction.

The member may be a corrugated member, and the slots may be in walls of the corrugation and directed longitudinally thereof. This again provides a relatively simple yet effective construction.

The slots may be arranged in groups of a plurality of slots. This provides an effective arrangement for backwashing.

The slots may be arranged in more than one row. This provides for even distribution of air for backwashing.

The slots may be arranged in rows so that they provide slots both close to the bottom and to the top of the tube in any orientation of the tube. This again provides for effective backwashing.

The length of each slot may be not greater than the longitudinal pitch along a particular row of slots. This provides for effective backwashing too, particularly as the slots may be staggered along the length of the member.

The slots may be formed by a laser or other thermal cutting device, and may comprise any suitable material, such as for example stainless steel, brass, aluminium or plastic.

According to a second aspect of the invention there is provided a system for backwashing a filter medium of a filter bed, comprising a plurality of members as hereinbefore defined, extending substantially parallel to or radially of one another and each being connected with a fluid supply means.

The fluid supply means may comprise a supply pipe for each member and a common manifold to which each supply pipe is connected.

According to a third aspect of the invention there is provided a filter, comprising a system as hereinbefore defined.

The members may extend laterally of the filter, suitable at or adjacent the base of the filter.

Devices, systems and granular media filters embodying the invention are hereinafter, described by way of example, with reference to the accompanying drawings.

Fig. 1 is a schematic perspective view of one embodiment of sand filter

according to the invention;

Fig. 2 is an elevational view of part of a member according to the invention, to a larger scale than Fig. 1;

Fig. 3 is an enlarged view of detail 'A' of Fig. 2;

Fig. 4 is an enlarged view of detail 'B' of Fig. 3;

Fig. 5 is a schematic perspective view, partially broken away, of a second embodiment of granular media filter according to the invention;

Fig. 6 shows to a larger scale than that of Fig. 5, a section through the filter floor;

Figs. 7 and 8 show, again to an enlarged scale respective perspective and transverse sectional views of "laterals" for air used in the filter of Figs. 5 and 6;

Fig. 9 shows an embodiment of granular media filter according to the invention where a feed manifold is buried in filter media; and

Figs. 10 shows an embodiment of granular media filter according to the invention utilising alternating water and air laterals.

Referring to the drawings there is shown in Fig. 1 a filter 1 which has a backwashing system 2 comprising a plurality of members in the form of slotted stainless steel pipes or tubes, or "laterals", 3 extending laterally of the filter below the filter medium, sand in the embodiment,

each tube being substantially parallel and each being connected in the embodiment to a manifold or air supply pipe 5 by a respective supply means or downpipe 6.

Each tube 3 has a plurality of longitudinally extending slots 7, through the circumference of the tubes, the slots being in the embodiment 0.25mm in width and being arranged in groups of three at different "levels", the two "upper" 7', 7" ones as viewed and as in use being angularly spaced by 120°, and the lower one 7''' being in use on the floor of the filter. The slots are preferably formed by a laser cutting device to provide uniformity of width and length, and with little or no swarf.

The filter includes water nozzles 8.

Referring now to Figs. 5 to 10, a second embodiment of sand filter is shown in Fig. 5 which comprises a structure 10 most often in concrete but frequently in steel with side walls 11 and a side channel 12 and duct 13 to provide means of feeding and collecting through flow of water and also backwash water. A granular filtering medium 14 is supported on a floor 15 which incorporates or supports a matrix of nozzles or orifices 16 which collect the filtrate and distribute the backwash water. In the kind of floor shown these orifices or nozzles 16 connect with a set of lateral pipes or manifolds 17 which in turn connect with the main feeder/collector duct or pipe 13.

To assist washing, air may be applied sequentially or simultaneously. In the kind of filter floor described this is achieved by laying a second set of lateral pipes 18 in between the water nozzles 16 or above them.

These air laterals 18 are fed from an air manifold 19 which may be located above the filter medium 14 as in Fig. 5 or buried within it. Fig. 6 shows a section of an arrangement with water laterals 17 set in the concrete floor 15 and with air laterals 18 set above, and within the sand 14.

The air laterals 18, as described, are perforated with lines of fine slots 20 spaced around the lateral pipe as illustrated in Figs. 7 and 8.

Fig. 9 shows an embodiment where the feed manifold 19 is buried in the medium 14 and is also slotted to admit air and retain the medium. In this way the medium above the manifold is also aerated and cleaned.

Fig. 10 shows an embodiment with alternating water 17 and air 18 laterals, where the former are not buried in the concrete but laid above it. In this case the water laterals are not connected to strainers but are of a similar design to the air laterals and are slotted similarly. They will normally be of larger diameter. In this case the water laterals if used in a filter similar to that shown in Fig.5 would still penetrate the wall of the filter into the duct 13.

Thus, in the embodiments of the invention fine slit lateral tubes, pipes or ducts are used to perform all the necessary functions. The slots, or slits, have a width less than that of the finest fraction of the granular medium so that super-imposed gravel layers are no longer necessary. These lateral pipes are suitably laid directly on the structural floor of the filter to distribute and collect water. They may also be used for the distribution of air and water in sequence. Where air is to be applied simultaneously separate systems of air and water distribution lateral

pipes may be laid between each other so that alternate pipes admit water and air respectively during washing.

In an alternative, separate air lateral systems are laid above or in between conventional lateral systems, or above gravel packing layers and in conjunction with nozzles which are then used for distribution of water only. One advantage of the separate lateral system is its suitability for retrofit conversions from separate sequential air and water to simultaneous air and water.

A particular feature of the fine slit or slotted pipe is the absence of separate components which as well as adding to cost can also become damaged. The length and width of the slits or slots and their spacing are as desired and the pressure loss is selected to achieve the intended accuracy of distribution. Because there are no intrusions into the pipe, as with many types of nozzle, the required accuracy can be achieved over longer lengths of pipe.

The avoidance of additional components and the labour involved in fitting them also reduces costs.

In one form pipes for use in filter underdrains may be slit with a fine slitting saw, but below 0.4mm these become rather fragile. Also sawing may create swarf which may block the slits unless considerable care is exercised.

In a preferred form laser cuts are used to achieve finer slits or slots. In this case the cut has a fused edge and a stringy swarf is not produced.

It is also preferred that the slits or slots be longitudinal (in contrast to common drainage pipes which are transverse) as in this direction the bending strength of the pipe is not compromised by the slit to the same extent.

It is inevitable that air lateral pipes will fill with water while the filter is in service. Laterals for water likewise may occasionally receive some air (e.g. on start up). Slits are therefore arranged in more than one line round the circumference of the pipe to permit filling and emptying, and the pressure loss through the slits during backwashing is always well in excess of the pressure difference corresponding to the head of water of the diameter.

In addition to laser cutting, and bearing in mind the sizes of filter media currently in use, other methods of forming fine slits may be used.

These could involve fusion of the pipe material, shearing as with expanded metal, and abrasive jet cutting.

By way of example and without restricting the scope of the invention, pipes used for water distribution may have a diameter of 50 to 150mm depending on the length and specific flow rate required, in lengths of several metres.

For air, typical diameters are 20 to 40mm e.g. in a preferred embodiment up to 38mm, say 32mm. Slits may be 0.15 - 0.3mm width and of lengths not exceeding the longitudinal pitch, but as required by the pressure loss calculations. Backwash water and air flow rates both range typically from 4 to 20 litres/m^2/second. The spacing between

lateral pipes and the pitch of the slits along the pipes is usually between 150mm and 250mm, but may be outside these limits.

It is usual to connect lateral pipes of such sizes to a larger diameter "header" or feed pipe or pipes which penetrate the outer wall of the tank or vessel. Such headers can cast a shadow on the bed and cause the medium over them to be washed less efficiently. It is a further feature of the invention that such headers may also be cut in a similar way to distribute air, and so eliminate such shadows.

In the above it has been assumed that the slits are formed in a circular section pipe. Rectangular or square ducts may also be slit to allow air or water to be distributed. This may be preferred in the case of headers, which can then be fitted against the wall or bottom corner of the vessel.

Lastly for distribution and collection of water the fine slits or slots described above may be arranged as a matrix in flat or corrugated floor panels. In the latter case rows of slits may be provided at different heights in the side of the corrugations and air may be distributed from below into the inverted channels of the corrugated sheet and thence via the upper slits into the granular media above. The corrugations then act as a set of lateral pipes. However the pressure loss for air will be limited by the height of the corrugations. Also, the slits or slots may be formed in a rollable material, which when rolled into a tubular form provide a device embodying the invention.

It will be understood that the invention described with reference to the drawings may be modified.

Thus, the tubes 3 may extend directly into the manifold 5 at a low level

thereof, without the need for downpipes 6. Also, there may be three or more rows of slots 7 which may be arranged in any desired respective orientation. Where there are three rows, some will be close to the top and some close to the bottom.

It will be further understood that embodiments of the invention as described herein with reference to the drawings utilize slots in a pipe or duct which perform both the function of controlling the pressure loss, and therefore the accuracy of distribution of air and/or water in a cleaning operation for the filter, as well as preventing entry of the filter medium or media into the pipe or duct, without the necessity of providing a porous structure that would in time be blocked by fine dirt and without the need to utilise expensive strainers, nozzles or other fittings attached to lateral pipes or ducts. In addition, the invention allows for adjustment of pressure loss on a site by site basis. The air in all the embodiments does not convey the dirt from the filter, which is effected by the water, but assists the cleaning process by providing agitation of the granular media so as to loosen dirt which is then carried away. This is so whether the air is introduced separately or concurrently with the water.